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Bühler(10) **Patent No.:** **US 9,109,115 B2**
(45) **Date of Patent:** **Aug. 18, 2015**(54) **POLYAMIDE MOULDING COMPOUND AND MOULDED ARTICLES PRODUCED HEREFROM**(71) Applicants: **EMS-PATENT AG**, Domat/Ems (CH);
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(57) **ABSTRACT**

The invention relates to a polyamide moulding compound made of a polyamide (PA MACM12) made of bis(3-methyl-4-aminocyclohexyl)methane (MACM) and dodecanedioic acid, a polyamide (PA PACM12) made of bis(4-aminocyclohexyl)methane (PACM) and dodecanedioic acid, a polyamide (PA MACM10) made of bis(3-methyl-4-aminocyclohexyl)methane and decanedioic acid, a polyamide (PA PACM10) made of bis(4-aminocyclohexyl)methane and decanedioic acid, a polyamide (PA MACM14) made of bis(3-methyl-4-aminocyclohexyl)methane and tetradecanedioic acid, a polyamide (PA PACM14) made of (bis(4-aminocyclohexyl)methane and tetradecanedioic acid and also mixtures and copolyamides thereof. Furthermore, the moulding compound comprises as impact modifier a functionalised styrene-ethylene/butylene-styrene block copolymer and also possibly further additives. Likewise, the invention relates to moulded articles produced from this polyamide moulding compound.

20 Claims, No Drawings

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POLYAMIDE MOULDING COMPOUND AND MOULDED ARTICLES PRODUCED HEREFROM

CROSS-REFERENCE TO A RELATED APPLICATION

This application claims the benefit of European Patent Application No. 13159541.5, filed Mar. 15, 2013, the disclosure of which is incorporated herein by reference.

The invention relates to a polyamide moulding compound made of a polyamide (PA MACM12) made of bis(3-methyl-4-aminocyclohexyl)methane (MACM) and dodecanedioic acid, a polyamide (PA PACM12) made of bis(4-aminocyclohexyl)methane (PACM) and dodecanedioic acid, a polyamide (PA MACM10) made of bis(3-methyl-4-aminocyclohexyl)methane and decanedioic acid, a polyamide (PA PACM10) made of bis(4-aminocyclohexyl)methane (PACM) and decanedioic acid, a polyamide (PA MACM14) made of bis(3-methyl-4-aminocyclohexyl)methane (MACM) and tetradecanedioic acid, a polyamide (PA PACM14) made of bis(4-aminocyclohexyl)methane (PACM) and tetradecanedioic acid and also mixtures and copolyamides thereof. Furthermore, the moulding compound comprises as impact modifier a functionalised styrene-ethylene/butylene-styrene block copolymer and also possibly further additives. Likewise, the invention relates to moulded articles produced from this polyamide moulding compound.

In the field of transparent polyamides with high light-permeability, two types of polymer are known, amorphous ones which have only a glass transition temperature and microcrystalline ones which have a glass transition temperature and a melting point. There are termed as amorphous, polyamides which show in dynamic differential calorimetry (differential scanning calorimetry, DSC) according to ISO 11357 at a heating rate of 20 K/min, a melting heat of at most 3 J/g, preferably at most 1 J/g.

From EP-A-O 725 101, amorphous, transparent polyamide moulding compounds with high chemical and thermal resistance and excellent dynamic loadability relative to fatigue loading are known, which are constructed from MACM (bis(4-amino-3-methyl-cyclohexyl)-methane) and dodecanedioic acid. Impact modifiers as possible additives are only mentioned in general in EP-A-O 725 101.

Transparent polyamide moulding compounds which are based on mixtures of PACM and MACM and have improved transparency are known from EP 1 369 447 A1. There are mentioned as possible additives, inter alia, impact modifiers, ethylene-glycidyl-methacrylate or polyethylene or polypropylene grafted with maleic acid anhydride being preferred.

Starting herefrom, it was the object of the present invention to provide impact-modified polyamide moulding compounds which are improved both with respect to the mechanical and to the optical properties relative to the state of the art. With respect to the optical properties, this relates in particular to minimising the opacity (haze) and maximising the transmission of the moulded articles produced from the impact-modified polyamide moulding compound according to the invention.

This object is achieved by the features of the polyamide moulding compound and the moulded articles described herein, and the advantageous developments thereof. Uses according to the invention are also described.

According to the present invention, a polyamide moulding compound is provided, which comprises the following components:

a) 82 to 96% by weight, relative to the sum of components a) to c), of at least one polyamide selected from the group consisting of

polyamide (PA MACM12) made of bis(3-methyl-4-aminocyclohexyl)methane and dodecanedioic acid, polyamide (PA PACM12) made of bis(4-aminocyclohexyl)methane and dodecanedioic acid,

5 polyamide (PA MACM10) made of bis(3-methyl-4-aminocyclohexyl)methane (MACM) and decanedioic acid, polyamide (PA PACM10) made of bis(4-aminocyclohexyl)methane (PACM) and decanedioic acid,

10 polyamide (PA MACM14) made of bis(3-methyl-4-aminocyclohexyl)methane (MACM) and tetradecanedioic acid,

polyamide (PA PACM14) made of bis(4-aminocyclohexyl)methane (PACM) and tetradecanedioic acid and also

15 mixtures and copolyamides thereof,

b) 4 to 18% by weight, relative to the sum of components a) to c), of a functionalised styrene-ethylene/butylene-styrene block copolymer as impact modifier and also

c) 0 to 8% by weight, relative to the sum of components a) to c), of further additives,

20 components a) to c) adding up to 100% by weight.

The polyamide moulding compound can basically comprise further components but preferably consists of components a) to c).

The combination of the mentioned polyamides with the impact modifier according to the invention led to moulded articles with improved mechanical properties, surprisingly also the optical properties being, at the same time, virtually unimpaired. In particular, as a result of the composition, according to the invention, of the polyamide moulding compound, a high increase in scattering behaviour (haze) of the moulded articles produced herefrom could be prevented.

The polyamide moulding compounds according to the invention lead to moulded articles with very good mechanical properties.

Thus the test pieces produced from the polyamide moulding compounds according to the invention preferably have a notch impact strength according to Charpy of at least 40 kJ/m², preferably of at least 50 kJ/m² and particularly preferred of at least 60 kJ/m². Determination of the notch impact strength is effected according to ISO 179.

Furthermore, the test pieces produced from the polyamide moulding compound preferably have a tear strength of at least 30 MPa, particularly preferred 40 MPa and/or a breaking elongation of preferably at least 80%, preferably at least 100% and particularly preferred 115%. These mechanical properties are determined respectively according to ISO 527.

It was particularly surprising that test pieces produced from the polyamide moulding compound according to the invention have a haze, measured on 2 mm thick round plates according to ASTM D 1003, of preferably at most 30% and particularly preferred at most 20%.

The test pieces produced from the polyamide moulding compound preferably have a light transmission of at least 75%, preferably of at least 85% and particularly preferred of at least 90%. Here also, the measurement was effected on 2 mm thick round plates according to

55 In a preferred embodiment, the polyamide moulding compound according to the invention has a proportion of 84 to 96% by weight, particularly preferred of 85 to 95% by weight of polyamide, respectively relative to the sum of components a) to c).

60 It is further preferred that the polyamide moulding compound has from 4 to 16% by weight, particularly preferred from 5 to 15% by weight, respectively relative to the sum of components a) to c), of the functionalised styrene-ethylene/butylene-styrene block copolymer.

The styrene-ethylene/butylene-styrene block copolymer concerns a linear triblock copolymer (SEBS) made of an ethylene/butylene block and two styrene blocks.

A preferred embodiment provides that the proportion of styrene in the functionalised styrene-ethylene/butylene-styrene block copolymer is preferably 20 to 45% by weight, particularly preferred 25 to 40% by weight and very particularly preferred 25 to 35% by weight.

The functionalised styrene-ethylene/butylene-styrene block copolymer preferably has a melt-volume flow rate of 90 to 160 ccm/10 min, particularly preferred of 100 to 150 ccm/10 min and very particularly preferred of 110 to 140 ccm/10 min. The melt-volume flow rate was measured at 275° C. and 5 kg according to ISO 1133.

There should be understood by functionalised styrene-ethylene/butylene-styrene block copolymer, a styrene-ethylene/butylene-styrene block copolymer functionalised by acid modification. This acid modification is effected by grafting with unsaturated carboxylic acids and/or unsaturated carboxylic acid derivatives, preferably a carboxylic acid derivative selected from the group consisting of unsaturated carboxylic acid esters and unsaturated carboxylic acid anhydrides, in particular with an unsaturated carboxylic acid and/or the anhydride thereof selected from the group consisting of acrylic acid, methacrylic acid, alpha-ethyl acrylic acid, maleic acid, fumaric acid, itaconic acid, citraconic acid, aconitic acid, tetrahydrophthalic acid and/or butenylsuccinic acid, i.e. that the styrene-ethylene-butylene/styrene block copolymer comprises grafted unsaturated carboxylic acids and/or unsaturated carboxylic acid derivatives in the molecule. The conditions under which the grafting of the styrene-ethylene/butylene-styrene block copolymer takes place is common knowledge to the person skilled in the art.

The proportion of unsaturated carboxylic acids and/or unsaturated carboxylic acid derivatives in the functionalised styrene-ethylene/butylene-styrene block copolymer is preferably 1.0 to 2.3% by weight, particularly preferred 1.1 to 2.0% by weight, very particular preferred 1.4 to 1.9% by weight.

In a further embodiment, the impact modifier is composed of a functionalised styrene-ethylene-butylene/styrene block copolymer proportion and a non-functionalised styrene-ethylene/butylene-styrene block copolymer proportion. The functionalisation proportion of the functionalised block copolymer and the respective proportions of the functionalised and of the non-functionalised block copolymer are chosen then such that, for the impact modifier, in total a functionalisation proportion of preferably 1.0 to 2.3% by weight, particularly preferred 1.1 to 2.0% by weight, very particularly preferred 1.4 to 1.9% by weight, results.

For particular preference, the acid modification of the styrene-ethylene/butylene-styrene block copolymer is effected with maleic acid anhydride, the proportion of maleic acid anhydride of the functionalised

styrene-ethylene/butylene-styrene block copolymer being preferably 1.0 to 2.3% by weight, particularly preferred 1.1 to 2.0% by weight, very particularly preferred 1.4 to 1.9% by weight.

The monomers used in the polyamides concern bis(3-methyl-4-aminocyclohexyl)methane (abbreviated to MACM) with a solidification point of -7 to -1° C. (CAS No. 6864-37-5, trade name, e.g. Laromin C260, manufacturer, e.g. BASF), bis(4-aminocyclohexyl)methane (abbreviated to PACM) with a melting point of 33.5 to 44° C. (CAS No. 1761-71-3, trade name, e.g. Dicykan, manufacturer, e.g. BASF) 1,12-dodecanedioic acid with a melting point of 130° C. (CAS No. 693-23-2, manufacturer, e.g. INVISTA Netherlands B.V.), 1,10-decanedioic acid with a melting point of 134-135° C. (CAS No. 111-20-6, reference source, e.g. Helm AG, Germany) and 1,14-tetradecanedioic acid with a melting

point of 126-127° C. (CAS No. 821-38-5, manufacturer, e.g. Cathay Industrial Biotech Ltd., China).

The relative viscosity of the polyamides, measured according to ISO 307 in m-cresol, is 1.50 to 2.2, preferably 1.55 to 1.95, particularly preferred 1.60 to 1.90, very particularly preferred 1.65 to 1.80.

For adjustment of the desired relative viscosity, polyamides of a different relative viscosity can be also mixed in.

The glass transition temperature of the polyamides, measured according to 11357, is 132 to 165° C., preferably 137 to 158° C.

Amongst the copolyamides according to the invention, PA MACM12/PACM 12, PA MACM10/PACM10 and PA MACM14/PACM14 are preferred.

Preferably the proportion of PACM to MACM in the copolyamides is adjusted such that they are amorphous.

In a particularly preferred (co)polyamide PA MACM12/PACM12 according to the invention, the PACM proportion of the diamine is 0 to 100% by mol, preferably 0 to 85% by mol, particularly preferred 0 to 55% by mol, very particularly preferred 0.1 to 50% by mol, the sum of the proportions of both diamine components MACM and PACM resulting in 100% by mol. As diacid, always 100% by mol of dodecanedioic acid is used in the PA MACM12/PACM12.

The proportion of PACM to MACM in the copolyamide MACM12/PACM12 is preferably adjusted such that is amorphous.

With respect to the possible additives, the polyamide moulding compounds according to the invention are not restricted. Rather all current additives for polyamide moulding compounds can be contained here. Preferably, the additives are selected from the group consisting of inorganic and organic stabilisers, in particular antioxidants, antiozonants, light protection agents, UV stabilisers, UV absorbers or UV blockers, lubricants, colourants, marking agents, pigments, carbon black, graphite, titanium dioxide, zinc sulphide, zinc oxide, barium sulphate, photochromic agents, antistatic agents, mould-release agents, optical brighteners, halogen-containing flame retardants, halogen-free flame retardants, natural layer silicates, synthetic layer silicates and mixtures thereof. The additives are preferably contained in a quantity of 0.1 to 6% by weight and particularly preferred of 0.2 to 4% by weight, relative to the total polyamide moulding compound. It is thereby preferred that the quantity of each individual additive is at most 3% by weight.

According to the invention also moulded articles are provided, which are producible from the above-described polyamide moulding compound. The moulded articles are thereby selected preferably from the group consisting of spectacle parts, in particular spectacle frames or spectacle earpieces, in particular for safety goggles, sports goggles or ski goggles, inspection glasses, throughflow meters, bursting discs, containers, housings or housing parts, in particular for shaving apparatus, depilating appliances, measuring devices, infrared keys, mobile phones, transportable playback devices, personal digital assistants (PDA), smart phones or memory media (e.g. USB sticks).

The moulding compounds according to the invention are used for the production of spectacle parts, in particular spectacle frames or spectacle earpieces, in particular for safety goggles, sports goggles or ski goggles, inspection glasses, throughflow meters, bursting discs, containers, housings or housing parts, in particular for shaving apparatus, depilating appliances, measuring devices, infrared keys, mobile phones, transportable playback devices, personal digital assistants (PDA), smart phones or memory media (e.g. USB sticks).

The subject according to the invention is intended to be described in detail with reference to the subsequent examples without wishing to restrict the latter to the specific embodiments shown here.

Production of a Polyamide Moulding Compound According to the Invention

The subsequent description of the production serves for illustration but is not intended to restrict the scope of the invention.

For the production of the polyamide moulding compound, the components are mixed on normal compounding machines, such as e.g. single- or twin-screw extruders or screw kneaders. The components are thereby metered individually into the feed or supplied in the form of a dry blend.

The additives can be used directly or in the form of a master batch. The carrier material of the master batch concerns preferably a polyolefin or a polyamide. Amongst the polyamides, there are suitable in particular PA 6, PA 12, PA 6/12 or polyamide a) itself.

For the dry blend production, the dried granulates and possibly further additives are mixed together. This mixture is homogenised by means of a tumble mixer, drum hoop mixer or tumble drier for 10-40 minutes. In order to avoid absorption of moisture, this can be effected under dried protective gas.

The compounding is effected at set cylinder temperatures of 230° C. to 295° C. In front of the nozzle, a vacuum can be applied or degassing can take place atmospherically. The melt is discharged in strand form, cooled in the water bath at 10 to 80° C. and subsequently granulated. The granulate is dried for 12-24 hours at 80 to 120° C. under nitrogen or in a vacuum to a water content of below 0.1% by weight.

Production of the Test Pieces from the Polyamide Moulding Compounds According to the Invention

The test pieces were produced on an injection moulding machine of the company Arburg, Model Allrounder 420 C 1000-250. Rising cylinder temperatures of 230° C. to 295° C. were thereby used. The mould temperature was 80° C. In the case of round plates for the measurement of the light transmission and of the haze, polished moulds were used.

The test pieces were used in a dry state, for this purpose they were stored after injection moulding for at least 48 h at room temperature in a dry environment, i.e. over silica gel.

The measurements were implemented according to the following standards and on the following test pieces made of the polyamide moulding compounds produced according to the above-described method.

Relative viscosity

ISO 307

Granulate

0.5 g in 100 ml m-cresol

Temperature 20° C.

Calculation of the relative viscosity (RV) according to $RV = \eta / \eta_0$ following section 11 of the standard.

Glass transition temperature (T_g):

ISO 11357

Granulate

Differential scanning calorimetry (DSC) was implemented at a heating rate of 20 K/min. The centre of the glass transition range which is indicated as T_g was determined according to the "half height" method.

Melt-volume flow rate (MVR)

ISO 1133

Granulate

Temperature 275° C.

Loading 5 kg

Tear strength and breaking elongation:

ISO 527 with a tensile speed of 50 mm/min

ISO test piece, standard: ISO/CD 3167, type A1, 170×20/10×4 mm,

Temperature 23° C.

Notch impact strength according to Charpy:

ISO 179/*eA

ISO test piece, standard: ISO/CD 3167, type B1, 80×10×4 mm,

Temperature 23° C.

*1=not-instrumented, 2=instrumented

Light transmission and haze:

ASTM D 1003

Round plates, thickness 2 mm, radius 37.5 mm

Temperature 23° C.

Measuring device Haze Gard plus of the company Byk Gardner with CIE light type C. The light transmission- and the haze value are indicated in % of the irradiated light quantity.

In the following, firstly the materials used for the comparative examples and examples according to the invention are listed.

Thus table 1 firstly shows the types of polyamides used.

TABLE 1

Component	Description	Manufacturer
PA MACM12	amorphous polyamide MACM12 made of bis(3-methyl-4-aminocyclohexyl)methane and dodecanedioic acid RV 1.70 (measured with 0.5 g in 100 ml m-cresol at 20° C.), glass transition temperature 155° C.	EMS-CHEMIE AG, Switzerland
PA MACM12/ PACM12	microcrystalline polyamide PA MACM12/PACM12 made of bis(3-methyl-4-aminocyclohexyl)methane, bis(4-aminocyclohexyl)methane and 1,12-dodecanedioic acid Molar ratio MACM:PACM = 30:70 RV 1.80 (measured with 0.5 g in 100 ml m-cresol at 20° C.), glass transition temperature 145° C. Melting point 237° C.	EMS-CHEMIE AG, Switzerland
PA PACM12	microcrystalline polyamide PACM12 made of bis(4-aminocyclohexyl)methane and 1,12-dodecanedioic acid RV 1.80 (measured with 0.5 g in 100 ml m-cresol at 20° C.), glass transition temperature 140° C. Melting point 250° C.	—

TABLE 1-continued

Component	Description	Manufacturer
PA MACMI/12	amorphous polyamide MACMI/12 in the molar ratio 65/35 made of bis(3-methyl-4-aminocyclohexyl)methane, isophthalic acid and laurilactam RV 1.56 (measured with 0.5 g in 100 ml m-cresol at 20° C.). Glass transition temperature 160° C.	EMS-CHEMIE AG, Switzerland
PA MACMI/MACMT/12	amorphous polyamide MACMI/MACMT/12 in the molar ratio 38/38/24 made of bis(3-methyl-4-aminocyclohexyl)methane, isophthalic acid, terephthalic acid and laurilactam RV 1.53 (measured with 0.5 g in 100 ml m-cresol at 20° C.). Glass transition temperature 194° C.	EMS-CHEMIE AG, Switzerland
PA 6I/6T/MACMI/MACMT/PACMI/PACMT/12	amorphous polyamide 6I/6T/MACMI/MACMT/PACMI/PACMT/12 made of 1,6-hexane diamine (38.5% by mol), bis(3-methyl-4-aminocyclohexyl)methane (7.5% by mol), bis(4-aminocyclohexyl)methane (2.7% by mol), isophthalic acid (24.3% by mol) and terephthalic acid (24.3% by mol) and laurilactam (2.7% by mol) RV 1.62 (measured with 0.5 g in 100 ml m-cresol at 20° C.). Glass transition temperature 159° C.	EMS-CHEMIE AG, Switzerland
PA 6I/6T	amorphous copolyamide 6I/6T made of hexamethylene diamine, isophthalic acid and terephthalic acid Molar ratio isophthalic acid:terephthalic acid = 67:33 RV 1.54 (measured with 0.5 g in 100 ml m-cresol at 20° C.). Glass transition temperature 125° C.	EMS-CHEMIE AG, Switzerland

RV = relative viscosity

In Table 2, the impact modifiers and additives used in the examples and comparative examples are listed.

TABLE 2

Component	Description	Trade name	Manufacturer
SZM (B1)	styrene-ethylene/butylene-styrene block copolymer with 30% by wt. styrene, grafted with 1.7% by wt. maleic acid anhydride MVR 130 ccm/10 min at 275° C. and 5 kg	Kraton FG1901GT	Kraton Polymers LLC, USA
SZM (B2)	copolymer of ethylene and glycidyl methacrylate with 8% by wt. glycidyl methacrylate	Lotader AX 8840	Arkema GmbH, Germany
SZM (B3)	copolymer of styrene and isobutylene	Sibstar 102T	Kaneka Belgium NV, Belgium
SZM (B4)	core-shell polymer with butadiene-methylmethacrylate copolymer as core and polystyrene as shell	Paraloid BTA- 753	Rohm and Haas, USA
SZM (B5)	polystyrene-polybutadiene-polyethylmethacrylate block copolymer	Clearstrength E920	Arkema GmbH, Germany
SZM (B6)	core-shell polymer with butadiene-styrene copolymer as core and polymethylmethacrylate as shell	Paraloid EXL- 3600	Rohm and Haas, USA
SZM (B7)	olefin copolymer of ethylene and octene-1, grafted with maleic acid anhydride	Paraloid EXL- 3808	Rohm and Haas, USA
SZM (B8)	copolymer of ethylene, acrylester and maleic acid anhydride with 1.3% by wt. maleic acid anhydride	Lotader 4700	Arkema GmbH, Germany
SZM (B9)	olefin copolymer of ethylene and octene-1, grafted with 0.5% by wt. maleic acid anhydride	Fusabond MN493D	DuPont de Nemours, USA
SZM (B10)	olefin copolymer of ethylene and propylene, grafted with maleic acid anhydride	Exxelor VA 1801	Exxon Mobil Chemicals, USA
stabiliser	N,N'-bis-2,2,6,6-tetramethyl-4-piperidiny-1,3-benzene dicarboxamide	Nylostab S- EED P	Clariant Corporation, USA
lubricant	calcium salt of octadecanoic acid and higher fatty acids with 16-18 C atoms	Calcium stearate S	FACI S.p.A., Italy
carbon black master batch	colour black master batch on polyethylene basis with 40% by wt. colour black	Euthylen Schwarz 00- 6005 C4	BASF Color Solutions, Germany

In Table 3, polyamide moulding compounds according to the invention are compared with polyamide moulding compounds known from the state of the art, with respect to the mechanical properties (tear strength, breaking elongation and notch impact strength according to Charpy) and also the optical properties (light transmission, haze).

When using 3% by weight of the impact modifier according to the invention (comparative example 7), too low a notch impact strength of the polyamide moulding compound results, whereas, at 20% by weight of the impact modifier according to the invention (comparative example 8), the haze value is too high.

TABLE 3

		Examples					Comparative examples		
Unit		1	2	3	4	5	6	7	8
Components									
PA MACM12	% by wt.	89.6	87.6	—	—	—	99.5	97.6	79.6
PA MACM12/ PACM12	% by wt.	—	—	89.6	—	—	—	—	—
PA PACM12	% by wt.	—	—	—	89.6	87.6	—	—	—
SZM (B1)	% by wt.	10	12	10	10	12	—	3	20
stabiliser	% by wt.	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
lubricant	% by wt.	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Tests									
tear strength	MPa	43	44	44	42	41	45	45	39
breaking elongation	%	126	131	121	116	119	150	146	155
notch impact Charpy 23° C.	kJ/m ²	70	70	80	76	78	13	17	89
light transmission	%	92.5	92.3	85.6	85.7	85.4	94	92.8	78.2
haze	%	13	15	22	25	26	1	8	47

SZM = impact modifier

The polyamide moulding compounds according to the invention with 10 or 12% by weight of the impact modifier according to the invention (example 1 to 5) show very good notch impact values and at the same time good haze values.

In Table 4, polyamide moulding compounds made of PA MACM12 with various impact modifiers, not according to the invention, are examined with respect to the mechanical and optical properties.

TABLE 4

		Comparative examples									
Unit		9	10	11	12	13	14	15	16	17	18
Components											
PA MACM12	% by wt.	87.6	89.6	89.6	89.6	89.6	89.6	89.6	89.6	89.6	89.6
SZM (B2)	% by wt.	12	10	—	—	—	—	—	—	—	—
SZM (B3)	% by wt.	—	—	10	—	—	—	—	—	—	—
SZM (B4)	% by wt.	—	—	—	10	—	—	—	—	—	—
SZM (B5)	% by wt.	—	—	—	—	10	—	—	—	—	—
SZM (B6)	% by wt.	—	—	—	—	—	10	—	—	—	—
SZM (B7)	% by wt.	—	—	—	—	—	—	10	—	—	—
SZM (B8)	% by wt.	—	—	—	—	—	—	—	10	—	—
SZM (B9)	% by wt.	—	—	—	—	—	—	—	—	10	—
SZM (B10)	% by wt.	—	—	—	—	—	—	—	—	—	10
stabiliser	% by wt.	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
lubricant	% by wt.	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Tests											
tear strength	MPa	41	39	38	43	47	44	43	40	45	47
breaking elongation	%	91	30	21	89	131	114	120	79	133	138
notch impact Charpy 23° C.	kJ/m ²	39	23	8	21	16	28	55	41	54	27
light transmission	%	82.0	83.6	88.7	71.5	84.2	76.1	66.4	60.5	60.8	69.5
haze	%	41	38	61	62	68	83	98	96	99	99

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The impact modifiers used in the polyamide moulding compounds of the comparative examples 9 to 18, in comparison with the impact modifier according to the invention (examples 1 to 5), improve the notch impact strength to a lesser extent and furthermore also lead to an extremely high increase in haze.

The impact modifier B2 (comparative examples 9 and 10) concerns ethylene-glycidyl-methacrylate as recommended in the state of the art (EP 1 369 447 A1). However, compared with the polyamide moulding compounds according to the invention of examples 2 and 1, it leads to an unbalanced combination of notch impact strength and haze.

The impact modifiers B7, B9 and B10 concern likewise impact modifiers recommended in EP 1 369 447 A1, namely polyethylenes or polypropylenes modified with maleic acid anhydride. However, they all lead to extremely high haze values.

In Table 5, polyamide moulding compounds with polyamide components, as are used in the state of the art, are examined with respect to the mechanical and optical properties.

TABLE 5

Components	Unit	Comparative examples			
		19	20	21	22
PA MACMI/12	% by wt.	89.6	—	—	—
PA MACMI/MACMT/12	% by wt.	—	89.6	—	—
PA 6I/6T/MACMI/MACMT/ PACMI/PACMT/12	% by wt.	—	—	89.6	—
PA 6I/6T	% by wt.	—	—	—	89.6
SZM (B1)	% by wt.	10	10	10	10
stabiliser	% by wt.	0.1	0.1	0.1	0.1
lubricant	% by wt.	0.3	0.3	0.3	0.3
Tests					
tear strength	MPa	52	58	62	62
breaking elongation	%	92	37	62	154
notch impact Charpy 23° C.	kJ/m ²	47	38	77	99
light transmission	%	52.2	46.0	21.9	21.6
haze	%	83	96	99	98

Comparative examples 19 to 22 show the effect of the impact modifier B1 according to the invention in combination with polyamides not according to the invention. In these polyamides, the impact modifier according to the invention even leads to polyamide moulding compounds which have unusably high haze values and extremely low light transmission values.

In Table 6, a polyamide moulding compound according to the invention with a proportion of carbon black is compared with a polyamide moulding compound from the state of the art which does not have the impact modifier according to the invention (comparative example 25), with respect to the mechanical properties and displays thereby both an improvement in breaking elongation and a great improvement in notch impact strength (examples 23 and 24).

TABLE 6

Components	Unit	Examples		Comparative examples
		23	24	25
PA MACM12	% by wt.	87.6	87.6	97.6
SZM (B1)	% by wt.	10	12	—
stabiliser	% by wt.	0.1	0.1	0.1
lubricant	% by wt.	0.3	0.3	0.3

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TABLE 6-continued

Components	Unit	Examples		Comparative examples
		23	24	25
carbon black masterbatch	% by wt.	2	2	2
Tests				
tear strength	MPa	43	43	45
breaking elongation	%	120	120	115
notch impact Charpy 23° C.	kJ/m ²	57	66	10

The invention claimed is:

1. A polyamide moulding compound comprising
 - a) 82 to 96% by weight, relative to the sum of components a) to c), of at least one polyamide selected from the group consisting of
 - polyamide (PA MACM12) made of bis(3-methyl-4-aminocyclohexyl)methane and dodecanedioic acid,
 - polyamide (PA PACM12) made of bis(4-aminocyclohexyl)methane and dodecanedioic acid,
 - polyamide (PA MACM10) made of bis(3-methyl-4-aminocyclohexyl)methane and decanedioic acid,
 - polyamide (PA PACM10) made of bis(4-aminocyclohexyl)methane and decanedioic acid,
 - polyamide (PA MACM14) made of bis(3-methyl-4-aminocyclohexyl)methane and tetradecanedioic acid,
 - polyamide (PA PACM14) made of bis(4-aminocyclohexyl)methane and tetradecanedioic acid and mixtures and copolyamides thereof,
 - b) 4 to 18% by weight, relative to the sum of components a) to c), of a functionalised styrene-ethylene/butylene-styrene block copolymer as impact modifier and
 - c) 0 to 8% by weight, relative to the sum of components a) to c), of further additives,
 components a) to c) adding up to 100% by weight;
- wherein test pieces produced from the polyamide moulding compound have a notch impact strength according to Charpy, measured according to ISO 179, of at least 40 kJ/m².
2. The polyamide moulding compound according to claim 1,
 - wherein test pieces produced from the polyamide moulding compound have a haze, measured on 2 mm thick round plates according to ASTM D 1003, of at most 30%.
3. The polyamide moulding compound according to claim 1,
 - wherein test pieces produced from the polyamide moulding compound have a tear strength of at least 30 MPa and a breaking elongation of at least 80% respectively measured according to ISO 527.
4. The polyamide moulding compound according to claim 1,
 - wherein test pieces produced from the polyamide moulding compound have a light transmission of at least 75%, measured on 2 mm thick round plates according to ASTM D 1003.
5. The polyamide moulding compound according to claim 1,
 - wherein the polyamide moulding compound comprises from 84 to 96% by weight, respectively relative to the sum of components a) to c), of the polyamide.
6. The polyamide moulding compound according to claim 1,

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wherein the polyamide moulding compound comprises from 4 to 16% by weight, respectively to the sum of components a) to c), of the functionalised styrene-ethylene /butylene-styrene block copolymer.

7. The polyamide moulding compound according to claim 1,
- wherein the functionalised styrene-ethylene/butylene-styrene block copolymer has a proportion of styrene of 20 to 45% by weight.
8. The polyamide moulding compound according to claim 1,
- wherein the functionalised styrene-ethylene/butylene-styrene block copolymer has a melt-volume flow rate of 90 to 160 ccm/10 min, respectively measured at 275° C. and 5 kg according to ISO 1133.
9. The polyamide moulding compound according to claim 1,
- wherein the functionalised styrene-ethylene/butylene-styrene block copolymer has a functionalisation proportion of 1.0 to 2.3% by weight.
10. A polyamide moulding compound comprising
 - a) 82 to 96% by weight, relative to the sum of components a) to c), of at least one polyamide selected from the group consisting of
 - polyamide (PA MACM12) made of bis(3-methyl-4-aminocyclohexyl)methane and dodecanedioic acid,
 - polyamide (PA PACM12) made of bis(4-aminocyclohexyl)methane and dodecanedioic acid,
 - polyamide (PA MACM10) made of bis(3-methyl-4-aminocyclohexyl)methane and decanedioic acid,
 - polyamide (PA PACM10) made of bis(4-aminocyclohexyl)methane and decanedioic acid,
 - polyamide (PA MACM14) made of bis(3-methyl-4-aminocyclohexyl)methane and tetradecanedioic acid,
 - polyamide (PA PACM14) made of bis(4-aminocyclohexyl)methane and tetradecanedioic acid and mixtures and copolyamides thereof,
 - b) 4 to 18% by weight, relative to the sum of components a) to c), of a functionalised styrene-ethylene/butylene-styrene block copolymer as impact modifier and
 - c) 0 to 8% by weight, relative to the sum of components a) to c), of further additives,
 - components a) to c) adding up to 100% by weight;
 - wherein the functionalised styrene-ethylene/butylene-styrene block copolymer is grafted at least partially with unsaturated carboxylic acids and unsaturated carboxylic acid derivatives.
11. The polyamide moulding compound according to claim 1,
- wherein the additives are selected from the group consisting of inorganic and organic stabilisers, antioxidants, antiozonants, light protection agents, UV stabilisers, UV absorbers or UV blockers, lubricants, colourants, marking agents, pigments, carbon black, graphite, titanium dioxide, zinc sulphide, zinc oxide, barium sulphate, photochromic agents, antistatic agents, mould-release agents, optical brighteners, halogen-containing flame retardants, halogen-free flame retardants, natural layer silicates, synthetic layer silicates and mixtures thereof and are contained in a quantity of 0.1 to 6% by weight relative to the total polyamide moulding compound, the quantity of each individual additive being at most 3% by weight.
12. A moulded article comprising a polyamide moulding compound according to claim 1.

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13. The moulded article according to claim 12, wherein the moulded article is selected from the group consisting of spectacle parts, spectacle earpieces or spectacle earpieces, for safety goggles, sports goggles or ski goggles, inspection glasses, throughflow meters, bursting discs, containers, housings or housing parts, shaving apparatus, depilating appliances, measuring devices, infrared keys, mobile phones, transportable playback devices, personal digital assistants, (PDA), smart phones, and memory media.

14. A method for the production of spectacle parts, spectacle frames or spectacle earpieces, safety goggles, sports goggles or ski goggles, inspection glasses, throughflow meters, bursting discs, containers, housings or housing parts, shaving apparatus, depilating appliances, measuring devices, infrared keys, mobile phones, transportable playback devices, personal digital assistants, (PDA), smart phones, or memory media, comprising utilizing the moulding compounds according to claim 1 in their production.

15. The polyamide moulding compound according to claim 1,

wherein test pieces produced from the polyamide moulding compound have a notch impact strength according to Charpy, measured according to ISO 179, of at least 50kJ/m².

16. The polyamide moulding compound according to claim 3,

wherein test pieces produced from the polyamide moulding compound have a tear strength of at least 40 MPa and a breaking elongation of at least 80%, respectively measured according to ISO 527.

17. The polyamide moulding compound according to claim 16,

wherein test pieces produced from the polyamide moulding compound have a tear strength of at least 40 MPa and a breaking elongation of at least 100%, respectively measured according to ISO 527.

18. The polyamide moulding compound according to claim 4,

wherein test pieces produced from the polyamide moulding compound have a light transmission of at least 85%, measured on 2 mm thick round plates according to ASTM D 1003.

19. The polyamide moulding compound according to claim 5,

wherein the polyamide moulding compound comprises from 85 to 95% by weight, respectively relative to the sum of components a) to c), of the polyamide.

20. A polyamide moulding compound comprising

- a) 82 to 96% by weight, relative to the sum of components a) to c), of at least one polyamide selected from the group consisting of

- polyamide (PA MACM12) made of bis(3-methyl-4-aminocyclohexyl)methane and dodecanedioic acid,
- polyamide (PA PACM12) made of bis(4-aminocyclohexyl)methane and dodecanedioic acid,
- polyamide (PA MACM10) made of bis(3-methyl-4-aminocyclohexyl)methane and decanedioic acid,
- polyamide (PA PACM10) made of bis(4-aminocyclohexyl)methane and decanedioic acid,
- polyamide (PA MACM14) made of bis(3-methyl-4-aminocyclohexyl)methane and tetradecanedioic acid,
- polyamide (PA PACM14) made of bis(4-aminocyclohexyl)methane and tetradecanedioic acid and mixtures and copolyamides thereof,

b) 4 to 18% by weight, relative to the sum of components a) to c), of a functionalised styrene-ethylene/butylene-styrene block copolymer as impact modifier and

c) 0 to 8% by weight, relative to the sum of components a) to c), of further additives,

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components a) to c) adding up to 100% by weight;

wherein test pieces produced from the polyamide moulding compound have a haze, measured on 2 mm thick round plates according to ASTM D 1003, of at most 30%.

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